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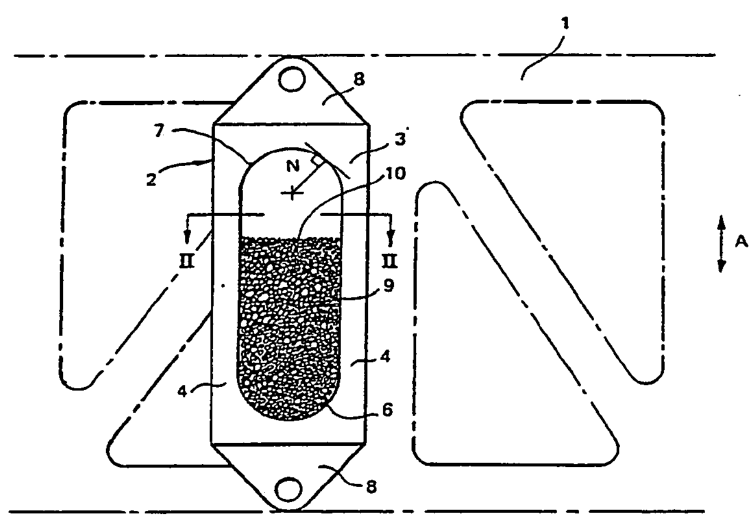
(54) Title: DEVICE FOR DAMPING OSCILLATIONS



(57) Abstract

A device for damping oscillations in a construction (1) particularly a part of an aircraft, as a stabilizer or the like, which is exposed to oscillations with an acceleration exceeding 1g, comprises at least one container (3) applied to the construction. The container has bottom and ceiling surfaces (6, 7) having their surface normals (N) in directions deviating from the direction of oscillation (A). To a great extent the volume of the container is occupied by a mass of mobile particles or small bodies (9) which, when the device is exposed to oscillations, by friction work consume oscillation energy from the construction and thereby damp the oscillations.

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Device for damping oscillations

A device for damping oscillations in a construction (1), particularly a part of an aircraft as a stabilizer or the like, which is exposed to oscillations with an acceleration exceeding 1g, comprising at least one container (3) applied in the construction and which is defined by bottom and ceiling surfaces (6, 7) spaced apart in the oscillation direction (A) and sidewalls (4) extending therebetween, said container containing movable elements counteracting the oscillations.

Oscillations or vibrations arise in many situations where mechanical constructions are combined with power sources of different kinds or are exposed to external forces. The oscillations cause disturbancies in sensitive equipment and have a negative effect on the strength of the construction. If the construction in question is a part of a transportation means, e.g. an aircraft, the oscillations will considerably reduce the comfort of both the passengers and the crew. Consequently there is a great demand for reducing the effect of the oscillations by damping them at the greatest extent or, if possible, to prevent them from arising.

In a flying aircraft so called buffeting arises, which is an aeroelastic response phenomenon that is excited by randomly varying air forces.

This buffeting problem and other oscillation problems can generally be affected in two ways, either by reducing the influence of the disturbing source or by limiting the response of the construction.

The influence of the buffeting source can to a certain extent be affected by improving the aerodynamic characteristics in the early project stages of the aircraft, whereafter suitable wind tunnel test can be carried out in order to confirm if the oscillation problem has got an acceptable solution.

In other technical fields the influence by the disturbing source can be limiteded, e.g. by suitable means for balancing and suspending the construction. However, unanticipated oscillation phenomena often arise, in spite of different measures of the kind mentioned above being taken during the early project stages, and such problems are then not discovered until the actual construction is operationally tested. In this situation there are many times nothing else to do but affecting the response of the construction. This can be done for instance by applying energy consuming dynamic systems in the form of spring suspended weights or the like which by their own energy consumption strive to bring the construction to stillness or by measures or devices of static nature changing the critical frequencies of the construction, the latter being seldom successful.

Known dynamic damping devices have the disadvantage of making the construction more complicated and have limited effect as they work only at a certain frequency or anyhow in a very narrow frequency range. It is known before to try to damp oscillations in heavy constructions, as antenna masts, by enclosing hanging chains or linked weights in a container or in a cavity in the construction. The damping effect in such a device is poor, in relation to the required volume and weight and the function is very dependant of the frequency. The conditions for applying the known damping devices in aircraft constructions are therefore missing, because it is here a desideratum to achieve highest possible damping effect with least possible sacrifice of volume and weight and also to damp serious oscillations occuring over a wide frequency range. The object of the present invention is to provide a device which fulfills the demands mentioned above.

This object is achieved with a device which is of the kind mentioned by way of introduction and has the characteristics according to claim 1.

The damping effect of this device is achieved by the fact that

the oscillation energy, independent of frequency, to a great extent is transformed to kinetic energy in the particles or small bodies, whereafter this kinetic energy as a consequence of mutual friction between the particles and friction between the particles and the innerwalls of the container in its turn is transformed to heat energy, which can be conducted to the surrounding. This kind of damping by friction premises, as mentioned by way of introduction, that the acceleration of the oscillations exceeds 1g.

In order to obtain a high friction and thereby improve the damping effect the innerwalls of the container can be provided with rough surfaces and for the same reason the particles or small bodies can have rough surfaces and an irregular shape. Preferably lead chips or lead balls are utilized and they shall occupy the container to about 75%. A suitable size of the particles is 1 - 3 mm.

The invention will now be described in detail with reference to the attached drawings.

Fig 1 is a longitudinal section along the line I - I in Fig 2 showing a damping device according to the present invention, applied in an aircraft structure.

Fig 2 shows the damping device according to Fig 1 in a cross section II - II in Fig 1.

Fig 3 shows how another embodiment of the device is installed in an aircraft stabilizer.

Fig 4 shows the device in Fig 3 in an exploded view.

In Fig 1 a mechanical construction is schematically shown with dash and dot lines. The construction can be a part of an aircraft structure and it is assumed to be affected by external forces

which strive to bring the construction into an oscillatory movement, back and forth, in the direction indicated by the arrow A.

The numeral 2 designates a damping device which is applied in an aircraft structure 1 to damp these oscillations according to the invention.

The device 2 comprises a container 3 which is made like an elongated box with three side walls 4 and whose remaining side is covered by a cover 5 which can be fixed to the container. The container will hereby, which can be seen in Fig 2, get a rectangular shape in the cross section and forms a cavity which in the longitudinal direction is limited by a bottom surface 6 and a ceiling surface 7, preferably of a semi-cylindrical shape, and by the inner surfaces of the sidewalls 4 and cover 5. This cavity contains a mass consisting of particles or small bodies 9 which occupies the container up to a level 10 which preferably is located at 3/4 of the height of the container. The particles or small bodies are metal and have rough, friction generating surfaces. The particles are preferably lead chips or lead balls.

The container 3 has external flanges 8 for securing the device 2 to the construction 1 in such a position that its longitudinal direction is oriented in the oscillation direction A. The innerwalls of the container suitably have rough surfaces. Likewise the surfaces of the ceiling 6 and the bottom 7 are rough and have the direction of their surface normals N deviating from the oscillating direction A. Hereby, as a consequence of the oscillation the particles or small bodies will be jerked towards and from the bottom and ceiling surfaces and constrained to collide with each other and with the side walls in crossing directions. It is appearant that this effect can be achieved with different shapes of the bottom and ceiling surfaces, e.g. surfaces composed of one or more flat inclined surface elements or semispherical surfaces, to mention some. The alternative embodiment which is shown in Fig 3 - 4 is particularly adapted for an aircraft stabilizer. Parts corresponding with parts in Fig 1 - 2 have the same designations.

Fig 3 shows the tip of an aircraft stabilizer in which, as a consequence of e.g. buffeting oscillations occur in the direction A. By numeral 12 is designated a damping device which is integrated in the construction 1 and which embodiment is conditioned by the demand of enclosing a device containing a sufficient damping mass in an available space. Consequently the numeral 12 relates to a damping device which is realized to fit like a supporting element in the structure of the stabilizer 1, preferably in a rib 13. Its extension in the direction A is here limited by the thickness of the stabilizer and to achieve enough damping effect the device has its largest extension in the chord direction. The construction is shown in detail in Fig 4 of which can be seen that the damping mass, consisting of particles or small bodies 9, of the same kind as in the device earlier described, is distributed to a number of containers 3. Hereby a uniform distribution of the mass can be maintained, even at exceptional flight attitudes, when the particles can be exposed to forces in the length direction of the rib. In order to avoid torque on the rib 13 the containers 3 ought to be symmetrically arranged in relation to the rib.

The containers 3 are formed by two housing halves 15 and 16 and a separating wall 17. This wall is tight and has the same extension in the ribs plane as the flanges 18 extending around the housing halves. Analogue to the previously described embodiment there is a cavity formed in each container and which cavity is defined by a bottom surface 6 and a ceiling surface 7, the inner surfaces of the sidewalls 4 of the container and on the remaining side by one of the plane surfaces of the separating wall 17. The internal geometry can be the same as in the device previously described and the container is closed by attaching the housing halves 15 and 16 with the screw joint 19 and 20, on each side of the separating wall 17. The container is at least to the half of its height filled with particles or small bodies 9, i.e. in the resting condition the distance from the bottom surface 6 to the level 10 is at least as great as the distance from the level to the ceiling surface 7. When assembling, one housing half is provided with particles or

small bodies so that every container is filled up to the correct level relative to the upper side of the flange 18, whereafter the separating wall 17 is attached as a cover and the housing half can be turned upside down to be fit together with the other housing half containing particles or small bodies. Screw joints 19 and 20 or the like keep the device together and fix it to the rib 13.

When the stabilizer oscillates in the direction A, the material in all the containers will be jerked up and down, provied that the acceleration exceeds 1g. The damping effect of the device is achieved, as mentioned before, by transforming the oscillation energy in the structure of the stabilizer to kinetic energy in the particles or small bodies and this kinetic energy is transformed to heat by friction. Although the space in the oscillation direction A is limited, an effective damping is achieved with this device. The effect is not limited to a certain frequency or a narrow frequency range, but is generally independent of the frequency.

Claims

1. A device for damping oscillations in a construction (1), particularly a part of an aircraft as a stabilizer or the like, which is exposed to oscillations with an acceleration exceeding 1g, comprising at least one container (3) applied in the construction and which is defined by bottom and ceiling surfaces (6, 7) spaced apart in the oscillation direction (A) and sidewalls (4) extending therebetween, said container containing movable elements counteracting the oscillations, c h a r a c t e r i z e d in that said elements consist of a mass of particles or small bodies (9), which are free to move relative to each other and to the container, which mass in its resting condition has a level (10) which is located at least as far away from the bottom surface(6) as from the ceiling surface (7), and that said surfaces are so formed that the direction of their surface normals (N)deviate from the oscillation direction (A), whereby particles or small bodies of the mass, when jerked towards and from the ceiling and bottom surfaces due to the oscillations, are constrained to impact with each other and with the sidewalls in crossing directions.

2. The device according to claim 1, c h a r a c t e r i z e d in that the particles or small bodies (9) are irregular in shape and have rough friction generating surfaces.

3. The device according to claim 1, c h a r a c t e r i z e d in that said level (10) is located at 3/4 of the distance from the bottom surface (6) to the ceiling surface (7).

4. The device according to claim 1, c h a r a c t e r i z e d in that the bottom and ceiling surfaces (6, 7) have spherical or semi-cylindrical shape.

5. The device according to claim 1 or 2, c h a r a c t e r i z e d in that the particles or small bodies (9) consist of lead chips or lead balls.

FIG 1

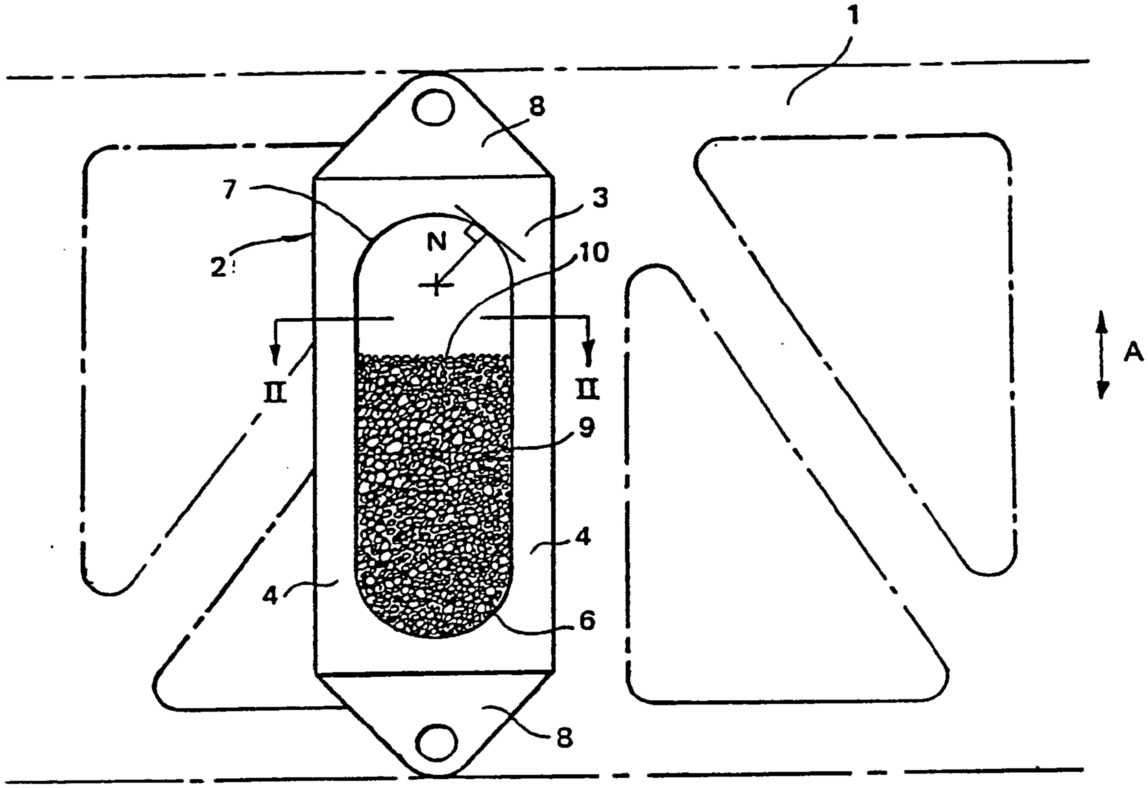
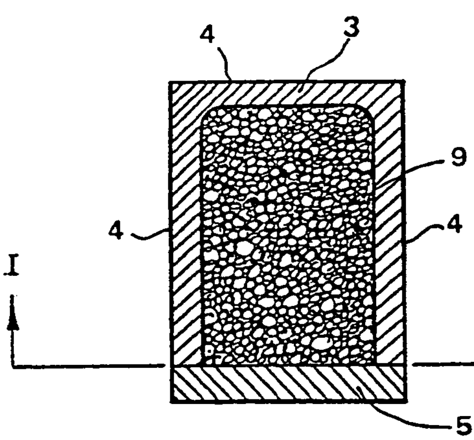


FIG 2



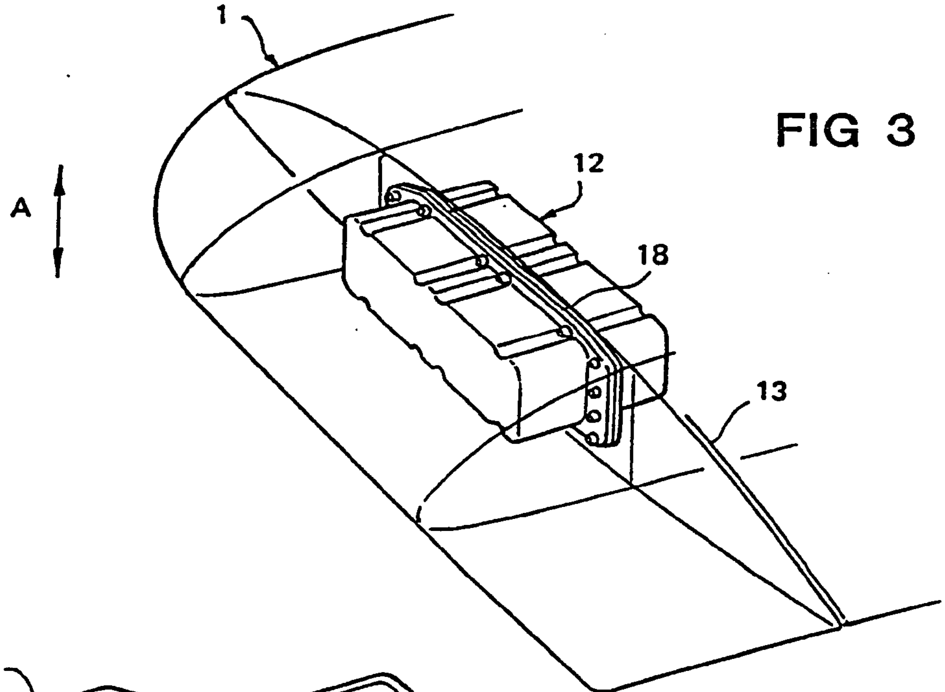


FIG 3

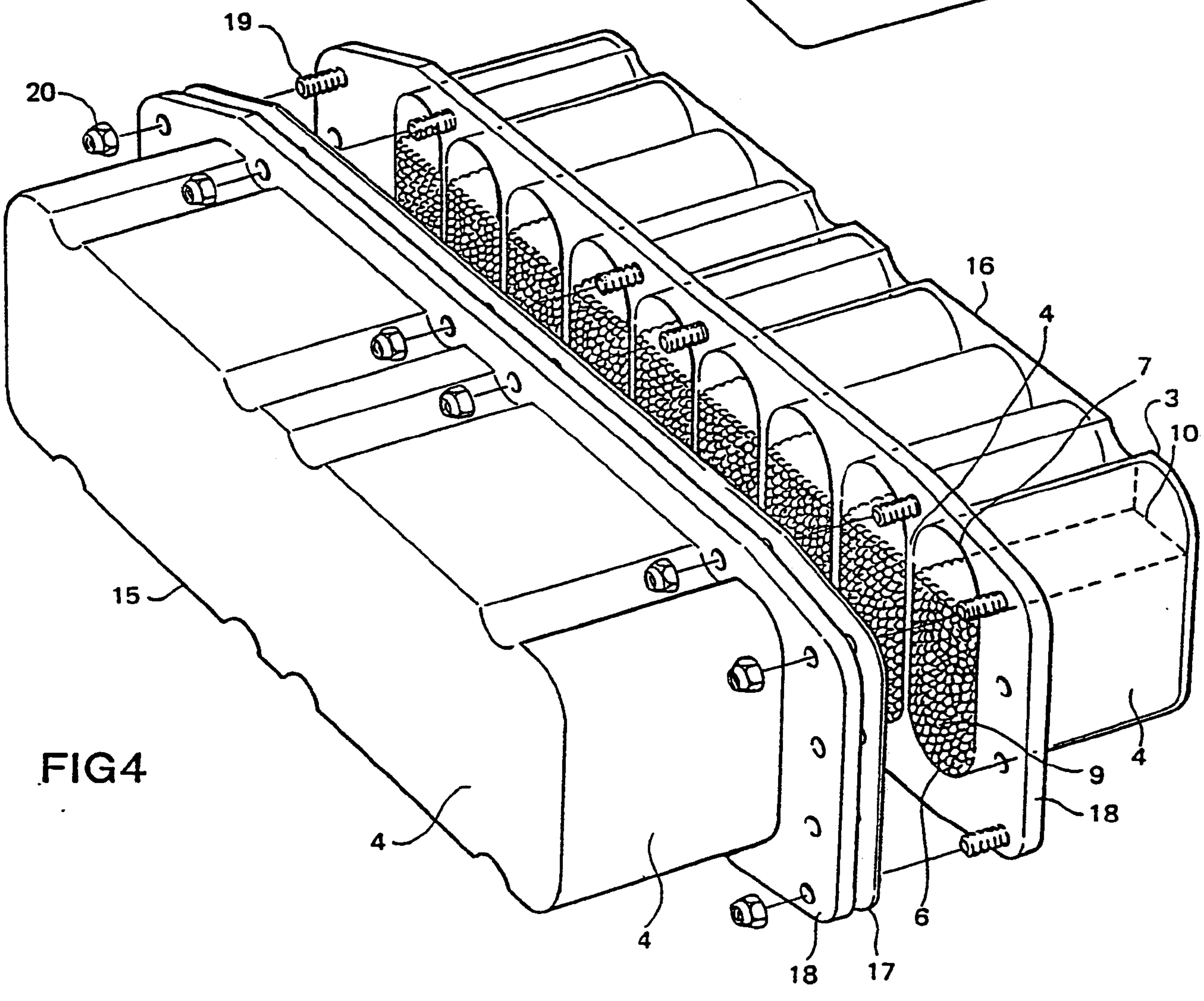


FIG4

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE85/00203

I. CLASSIFICATI N F SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

F 16 F 15/02 // B 64 C 3/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	F 16 F 15/02, /28; G 01 M 1/32, /36; B 64 C 3/00, 5/00, 17/00, /08, 27/51
US Cl	188:378, 381; 244:75

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	Derwent's abstract No E9129 E/17, SU 844 855 (SAVIN E) 10 July 1981	
A	Derwent's abstract No P2006 E/43, SU 894 381 (HEAT ENG RES INST) 30 December 1981	

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1985-08-08	1985-08-09
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Hans Hagström

VH

FIG 1

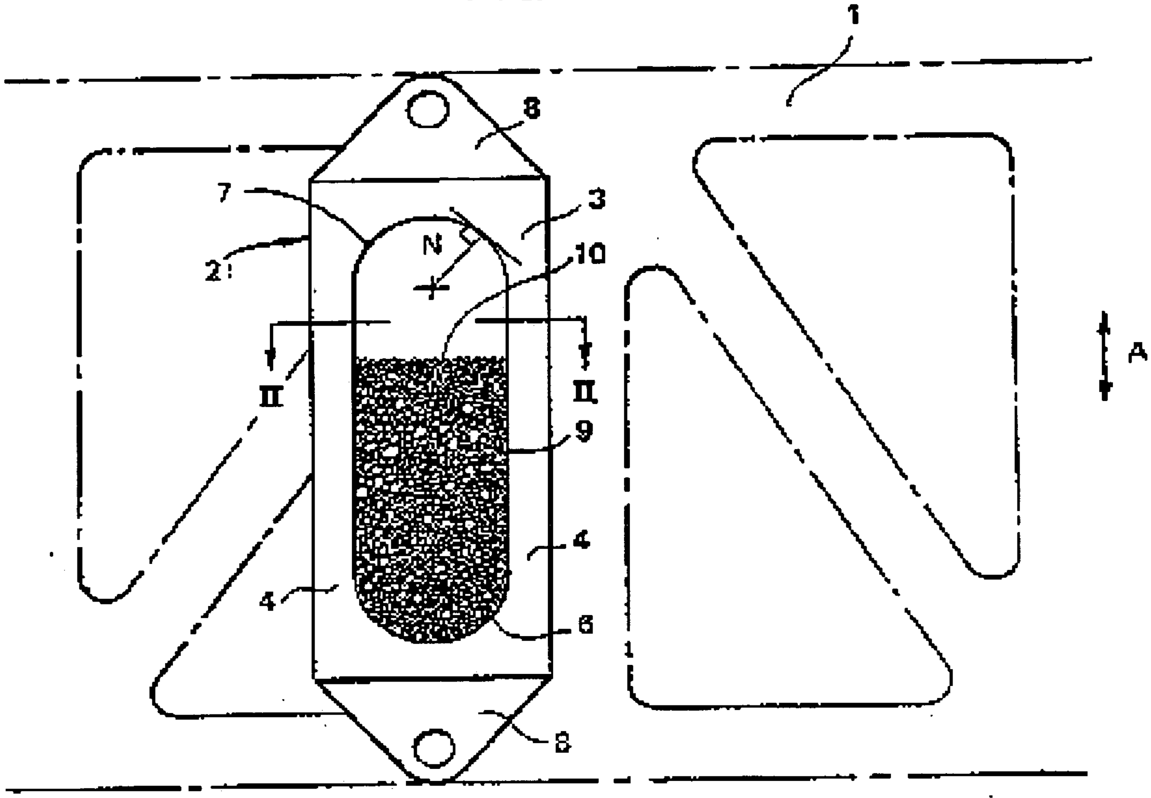
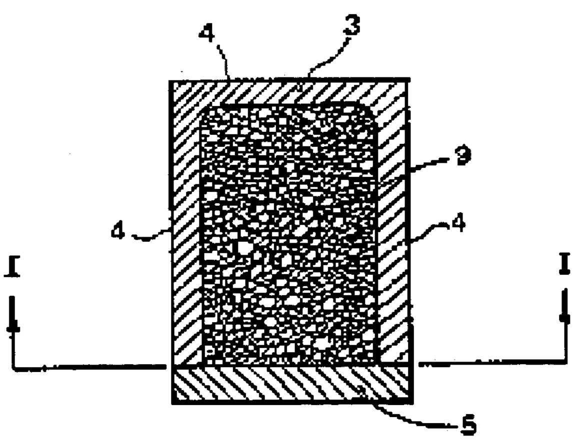


FIG 2



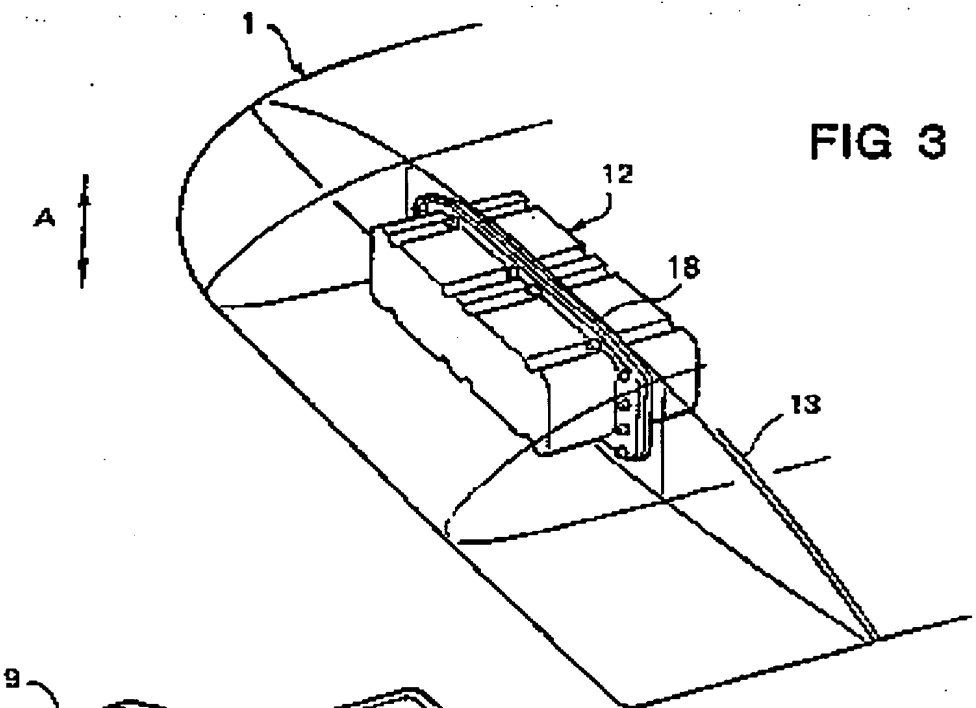


FIG 3

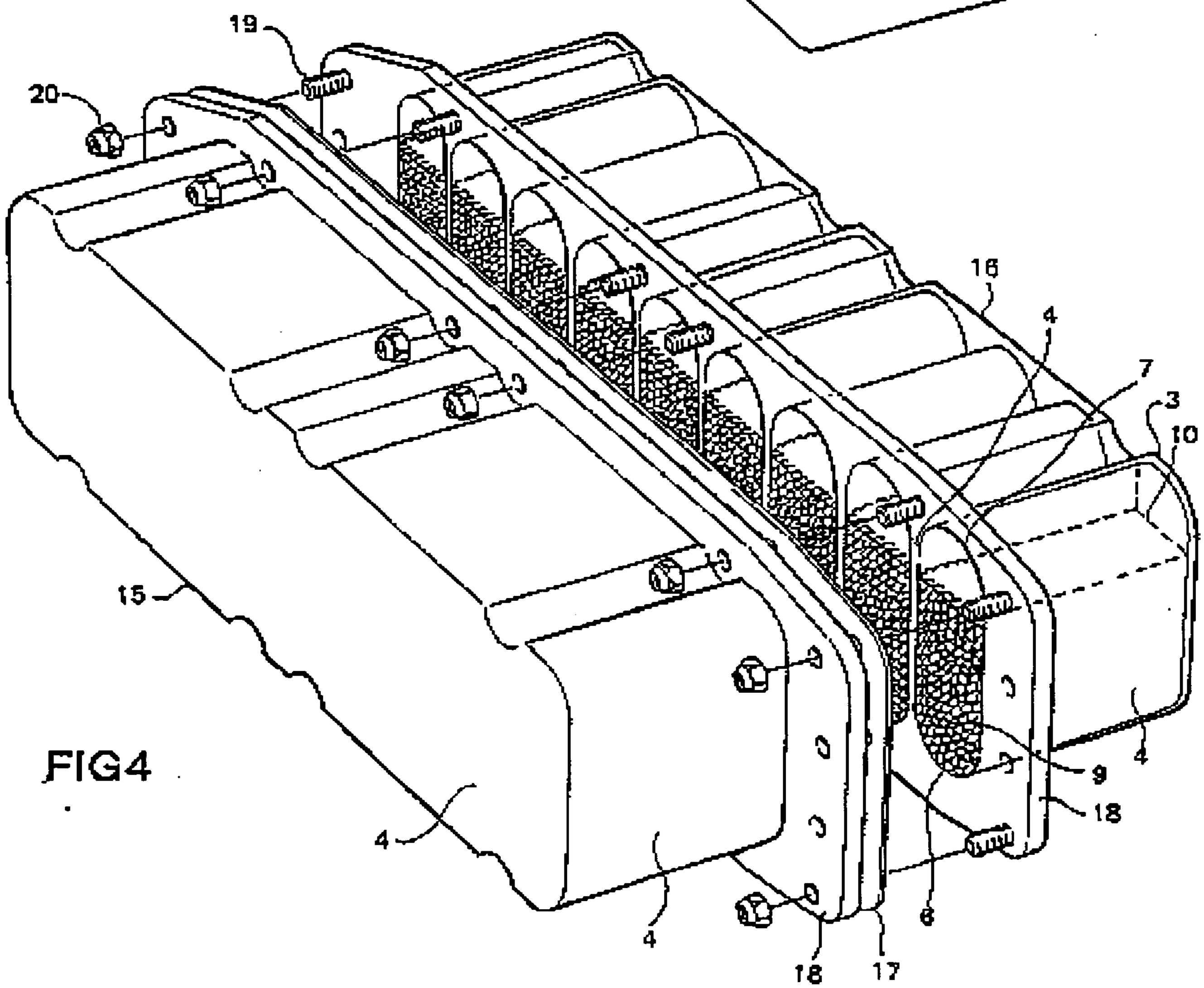


FIG4